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Consequences of Brexit and Options for a 'Global Britain'

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Abstract

The United Kingdom has opted to leave the European Union. The consequences of Brexit on international trade are large and negative. While the UK aims for new, ambitious trade agreements after Brexit, it is not explicit about the type of agreements it envisions or with whom specifically. This paper considers the UK's options. We confirm Brexit's substantial, negative trade effects for the UK, EU, and major countries around the world. After reviewing all potential options, our answer to the question whether the UK has an alternative for the existing agreement with the EU is: No. Paradoxically, only a trade agreement with the EU can compensate for Brexit's trade losses.

JEL Codes: F13, F14

Key Words: Brexit, Gravity model, Trade predictions

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1 Introduction

On June 23, 2016, the people of the United Kingdom voted to leave the European Union (EU), the so-called Brexit. In a letter dated March 29, 2017, British prime minister informed the EU of the intention to terminate its EU membership.

The EU swiftly responded on March 31 that this *'...creates significant uncertainties that have the potential to cause disruption, in particular in the UK but also in other member states* (p.2).'[1] Indeed, the Brexit creates uncertainties on many fronts: political, social, and economic. In this paper, we will focus on the economic aspects of the Brexit and highlight the consequences of the Brexit on trade flows, and analyse the trade options of the UK.

From an international trade perspective, the choice of the UK to leave the EU is remarkable. Leaving a large free trade area as the EU is most likely trade and welfare reducing. Without a new agreement, relative trade barriers will change by making trade with the EU relatively more expensive compared to outside-EU trade, resulting in trade creation with the non-EU world and trade diversion away from the EU. The balance between these developments is most likely trade and welfare reducing, as trade barriers between the UK and the largest trading block in the world increase.[2] This sombre evaluation is corroborated by almost all analyses of Brexit. The estimates range between roughly 1.5% reduction in GDP to more than 7%, depending on assumptions made how the Brexit takes place (Baldwin, 2016). Only 'Economists for Brexit' produced a positive estimate, but this seems to be an outlier in the available estimates (see Miles, 2016, p. 31, for an overview).

[1] See for the letter of the British prime minister: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/29_03_17_article50.pdf. The answer from the EU: EU Draft Guidelines following the United Kingdom's notification under Article 50 TEU, Council of The European Union, XT 21001/17, Brussels.

[2] The so-called Kemp-Wan theorem gives the condition for the net effect to be positive: trade must remain fixed after the change in membership. So, trade barriers have to adjust in special ways to make this happen (see Feenstra (2016) for a discussion).

The challenge for the UK is to find a new position within the world of trade agreements. The letter of the UK prime minister (see note 1) indicates that the principles of the Brexit with respect to international trade are outlined in the White Paper of February 2, 2017, which says that the UK aims to (p.8) '*forge a new strategic partnership with the EU, including a wide reaching, bold and ambitious free trade agreement...*' and that '*we will forge ambitious free trade relationships across the world*'.[3] The various comments of politicians indicate that the negotiations will at times become confrontational; the UK links the trade negotiations to security issues and Gibraltar, whereas Donald Tusk (EU president) has warned that 'cherry picking' by the UK will not be accepted by the EU (see footnote 1).

In this paper, we will not predict or speculate what the most likely outcome of Brexit negotiations will be, but instead analyse the options for the UK with respect to international trade. The UK indicated in the White Paper that it would like to 'forge new trade agreements.' The question we answer in this paper is what trade agreements could be an alternative to the current situation of UK's EU membership. Based on a state-of-the-art gravity model we will first estimate with our data – value-added trade data – what the consequences are of Brexit. Next, we will analyse options for the UK that have been put forward in several policy discussions – including a trade partnership with the US, or with various other parts of the world – and confront those estimates with a (renewed) partnership with the EU. Our broad conclusion is simple: the UK has no alternative than a trade agreement with the EU unless it is willing to accept a trade reduction. Given this conclusion, two important and related questions would be why the UK citizens voted by a 52-48% margin for Brexit on June 23rd, 2016 and why there were distinct regional differences in the Brexit vote across the UK. The answers to these questions are beyond the current paper, but

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/589191/The_United_Kingdoms_exit_from_and_partnership_with_the_EU_Web.pdf

for the political and regional economy aspects of Brexit we refer the interested reader to Becker et al. (2016) and Los et al. (2017).

The paper is structured as follows. Section 2 describes the methodology and our dataset. Section 3 presents our estimation results. Finally, section 4 concludes.

2 Methodology

2.1 Gravity equation with counterfactual scenarios

A well-known and well-established method to estimate the consequences of trade agreements (TAs) is the so-called gravity equation (for a survey, see Head and Mayer 2014). This is an accepted method to evaluate the effects of changes in variables that in some way affect barriers to trade between countries.[4] Key in modern formulations of the gravity models are the so-called Multilateral Resistance (MLR) terms. These terms are related to price indices, and are important to analyse the effects of a TA between, say, two countries on the rest of the trading system. Without these terms, the simulated effects of a TA would only affect the two countries involved. With these price index terms present, however, a TA changes the MLR terms and thus affect the whole trading system as trade between any pair of countries takes place against the background of changed price indices. We provide some simple micro-foundations of the model, based on monopolistic competition, to illustrate how this works.

We follow Baldwin and Taglioni (2007), as summarized in Van Bergeijk and Brakman (2010, p. 9-10) and proceed in 6 steps.

[4] Theories of economic growth and development do not motivate our analysis because such models assume that future levels of post-Brexit investment and innovation are known. Our approach is more modest in the sense that the chosen theoretical framework and analysis yield comparative statics.

Step 1: The first step is an equilibrium equation which says that the value of trade flows from country *i* to *j*, $p_{ij}x_{ij}$, should equal the share, s_{ij}, that country *i* has in expenditure of *j*, E_j: $p_{ij}x_{ij} = s_{ij}E_j$, where p_{ij} is the import price from *i* to *j*.

Step 2: Assuming the familiar constant elasticity of substitution (CES) demand structure, it is straightforward to derive demand for each individual product and calculate s_{ij}, explicitly:

$s_{ij=}\left(\frac{p_{ij}}{P_j}\right)^{1-\sigma}$, where $P_j = \left(\sum_{i=1..N} n_i \left(p_{ij}\right)^{1-\sigma}\right)^{1/(1-\sigma)}$

where P_j is the exact price index associated with the CES demand structure; $\sigma > 1$ is the elasticity of substitution between varieties 'n_i'; *N* is the number of countries. The number of varieties is determined by profit maximization (under monopolistic competition) and the zero-profit condition.

Step 3: Trade costs are crucial in gravity models. Let $t_{ij} > 1$ indicate all bilateral trade costs from country *i* to *j* (man-made and natural costs), then the price in market *j* equals: $p_{ij} = p_i t_{ij}$, where p_i is the so-called mill price of a product in the market of origin, *i.*

Step 4: The gravity model describes total bilateral trade, T_{ij}, for industries, or countries, so we have to aggregate across varieties (products): $T_{ij} = n_i p_{ij} x_{ij} = n_i s_{ij} E_j = n_i \left(p_i t_{ij}\right)^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}}$, where we use $s_{ij=}\left(\frac{p_{ij}}{P_j}\right)^{1-\sigma}$, and the price including transportation costs.

Step 5: We assume that all goods are traded, implying that the total output of a country *j*, Y_j, equals total sales to all destination countries (including the home country): $Y_i = \sum_j T_{ij} = n_i (p_i)^{1-\sigma} \sum_j \left(t_{ij}^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}}\right)$, where we use the result of step 4. We can re-write this

equation as follows: $n_i(p_i)^{1-\sigma} = \frac{Y_i}{\Pi_i^{1-\sigma}}$, where $\Pi_i = \left(\sum_j \left(t_{ij}^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}}\right)\right)^{1/(1-\sigma)}$, and substitute this in the final step of 4 to obtain:

Step 6: A gravity model [by combining step 4 and step 5]:

$$T_{ij} = Y_i E_j \left(\frac{t_{ij}}{P_j \Pi_i}\right)^{1-\sigma}. \quad (1)$$

Equation (1) is a basic formulation of a modern gravity equation and is the basis of our empirical specification (see section 2.3).

In empirical research, other variables are included that affect trade barriers, such as a common language between *i* and *j*, a shared border, similar history (colonies), and most importantly for this paper, being part of a common TA. Note that bilateral trade is not only affected by variables describing the bilateral relation between *i* and *j*, but also by Π_i and P_j, the MLR terms. These terms depend on all prices in the system. Changes in trade costs between two countries thus also affect the rest of the trading system. As a result, we have in our simulations two types of effects: those that directly affect the trading partners themselves because they exit/enter a TA, and the effects with respect to the rest of the world through the MLR terms (price index effects).

In practice, the estimation of equation (1) is difficult as the MLR terms depend on parameters that have to be estimated. Anderson and Van Wincoop (2003) have a custom programmed iteration model to find the estimates of equation (1). We follow Anderson et al. (2015), as they have developed a more straightforward estimation method (see also Anderson and Yotov 2015; Larch and Yotov 2016). A crucial step in their method is to re-estimate the model as described in steps 1-6, for the alternative policy scenario, the counterfactual model.

First, equation (1) is estimated to calculate the implied baseline trade costs, $\left(t_{ij}\right)^{1-\sigma}$. Next, the new policy scenario is evaluated by switching on/off, in our case, a TA dummy. In case of Brexit, the TA dummy that describes the EU membership of the UK becomes zero. Given the estimates, one can calculate the counterfactual implied trade costs and substitute these in the expressions for the MLR terms as defined above. This results in counterfactual MLR terms. By imposing market clearance, one can calculate the new values of Y_i. In this way, we can compare the original (baseline) situation to counterfactual situations and calculate changes in trade flows and income.

Note that we do not differentiate between types of TAs; some TAs are broad and cover a lot of different provisions, others are narrower. Because we do not know how negotiations between the UK and various trading blocs in the world will incorporate various elements, we opt for the simple way to describe a TA, i.e. with a binary dummy.[5]

In this paper, we will focus on the so-called 'full endowment general equilibrium' trade effects, i.e. the change in trade once income and expenditure have adjusted to the new MLR terms and counterfactual trade costs (for a detailed discussion, see Larch and Yotov 2015).

2.2 Data

While traditional estimates of the gravity equation rely on gross trade data, a growing literature has emphasized the importance of using novel measures of value-added exports (VAX) data to account for the international fragmentation of production (see, e.g., Johnson and Noguera 2012, Koopman et al. 2014, and Kaplan et al. 2017). In line with this development, we explicitly use data on trade in value-added (covering both manufacturing and services) instead of gross exports (typically only covering manufacturing). Value-added

[5] Kohl et al. (2016) differentiate between various provisions in trade agreements and in addition differentiate whether or not a provision is legally enforceable; resulting in 52 different elements in a trade agreement.

data are more relevant for exercises like we present in this paper because changes in value-added trade are more directly linked to income and welfare of the countries involved.[6]

Value-added exports are calculated based on the 2016 release of the World Input-Output Database (WIOD), which covers the period 2000-2014.[7] The 43 countries covered in our analysis account for more than 85% of world GDP. By construction, WIOD provides a rest-of-the-world (ROW) aggregate to ensure full world coverage of value-added trade. A list of countries is provided in Appendix Table A1. For a detailed description of WIOD, its construction and applications, see Timmer et al. (2015, 2016). Other typical gravity-equation controls (bilateral distance, contiguity and common language) are from CEPII (Mayer & Zignano 2011). Similar to Anderson et al. (2015), bilateral distance between WIOD country *i* and the ROW is calculated as the average bilateral distance between *i* and all non-WIOD countries in the CEPII bilateral distance database. Trade agreement data for 2000-2011 are from Kohl (2014) and updated for 2012-2014 using the WTO Regional (Preferential) Trade Agreements Database.

2.3 Empirical strategy

Taking logs of equation (1) results in a simple empirical specification of a gravity model. Note that because we estimate the gravity model as a cross-section, *Y* and *E* are captured by the fixed effects. Closely following Anderson et al. (2015), we estimate the following equation with PPML in annual cross-sections[8]:

[6] Given data-limitations, we cannot estimate the gravity equation on a regional level; this would require a global regional (value-added) trade matrix which is currently not available.

[7] Our results are qualitatively similar when using gross trade and production data as used in Anderson and Yotov (2016). All results are available from the authors upon request.

[8] We rely on Anderson et al. (2015)'s method to econometrically perform counterfactual gravity computations in cross-sections. At the time of writing, a panel version was not available. Therefore, to account for possible time trends in our data, we calculate annual effects first, and then take the average over the entire sample period, i.e. 2000-2014. Average effects are discussed throughout the main text and reported in Tables A1 and A3. Annual effects for the "Hard Brexit" scenario are presented in Table A2; all other annual effects are available from the authors upon request.

$$VAX_{ij} = \ln(DIST_{ij}) + CNTG_{ij} + BRDR_{ij} + TA_{ij} + F_i + F_j + \varepsilon_{ijt} \quad (2)$$

where VAX is the value-added exports of origin *i* to destination *j* at destination prices; DIST is the bilateral distance between the trade partners in kilometres; CNTG is a dummy which is 1 when *i* and *j* share a common border and 0 otherwise; BRDR is a binary variable equal to 1 if international trade is involved and 0 if the country is trading with itself (see step 5 in section 2.1); TA is 1 when *i* and *j* have a trade agreement and 0 otherwise; F_i and F_j represent origin and destination fixed effects, respectively, and are the MLR terms (after correction for *Y* and *E*, see equation (1)).

In the following section, we will present the results of a series of different scenarios that can be calculated with the methodology outlined above.

First, we consider the case of a hard Brexit, in which the UK terminates its EU membership and all trade agreements to which the UK belonged as member of the EU.[9] This scenario comes down to the case where Brexit means that the UK no longer has a preferential trade agreements (PTA) with the EU. In order to calculate the counterfactual trade costs, the binary TA variable will be "switched off", i.e. from 1 to 0, for all country-pairs involving the UK and another EU member. Note that we do not take the depth of trade agreements into account (Kohl et al, 2016) and that being part of a trade agreement is simply a binary option, see also Ebell (2016). An alternative option might be a so-called "soft Brexit", in which the UK leaves the EU and retains its membership in all the EU's trade agreements with countries such as Canada, Mexico and South Korea, in this case the UK thus maintains its PTAs with

[9] Note that all EU members' trade agreements are centralized at the EU level. The UK does not have trade agreements that are independent and separate from the EU.

the EU (but without being part of the EU single market like with the current EU membership). [10, 11]

Second, once a "hard Brexit" is in place, we explore which trade agreements the UK can pursue in its "Global Britain" strategy. One possible option is that the UK and US governments negotiate a US-UK trade agreement. We will show that such an agreement would only have a minor role in reducing the UK's losses. To add insult to injury, even the most extreme case of a "Global Britain" in which the UK has a TA with all non-EU countries would still not be sufficient to offset the UK's post-Brexit loss in trade.

Finally, one may ask how severe the trade impact of Brexit would be in light of other potential threats to the international trade regime. We will consider the case of the US abandoning the North American Free Trade Agreement (NAFTA), the dissolution of the EU, and, as a worst-case scenario, the collapse of all trade agreements worldwide.

3 Results

A full overview of all results is presented in Appendix Table A1 (average percentage change compared to baseline, i.e. pre-Brexit), Appendix Table A2 (annual changes for the hard Brexit scenario) and Appendix Table A3 (change in absolute values).

[10] For the purpose of our analysis, it does not matter whether the UK signs a new bilateral agreement with current EU TA partners, or (re)negotiates its membership in existing agreements between the EU and its TA partners.

[11] While there is some debate as to the merits of a 'Norway' construction (i.e. free trade, but no labour mobility), such a scenario cannot be computed with our counterfactual gravity equation setup. The reason is that that TA variable is already 1 for UK-EU members in the baseline, so that nothing would change in the counterfactual scenario in which an alternative agreement replacing the UK's current EU membership is activated.

3.1 Great Brexit

The set up for our discussion of the various scenarios is relatively straightforward. Ranked on the horizontal axis by the size of their economy, as measured by *ln(GDP)*, we show for each country in our sample the effect of the change in the trade agreement status on value-added exports (in %) using the methodology outlined in section 2. The bubble for each country is proportional to a country's value-added exports in 2014. These results are full endowment general equilibrium effects, that however still could underestimate the impact of Brexit or related scenarios (see also Dhingra et al. 2016) for mainly two reasons. First, the effects are static in the sense that the dynamic negative impact of a reduction in trade could have on productivity growth is not taken into account. Second, the analysis is only concerned with trade effects and ignores the changes on international factor mobility that the changes in trade agreements might give rise to. So, in the case of Brexit, the analysis does not deal with the possible effects of changes in labour migration or (re)location decisions of (multinational) firms. Having said so, the first scenario when estimating (2) and "creating" the counterfactual is the case of a "hard Brexit" where the UK not only leaves the EU but also all other trade agreements it currently has as an EU member. The results are shown in Figures 1 and 2 below (where Figure 2 is just a blown-up version of Figure 1).

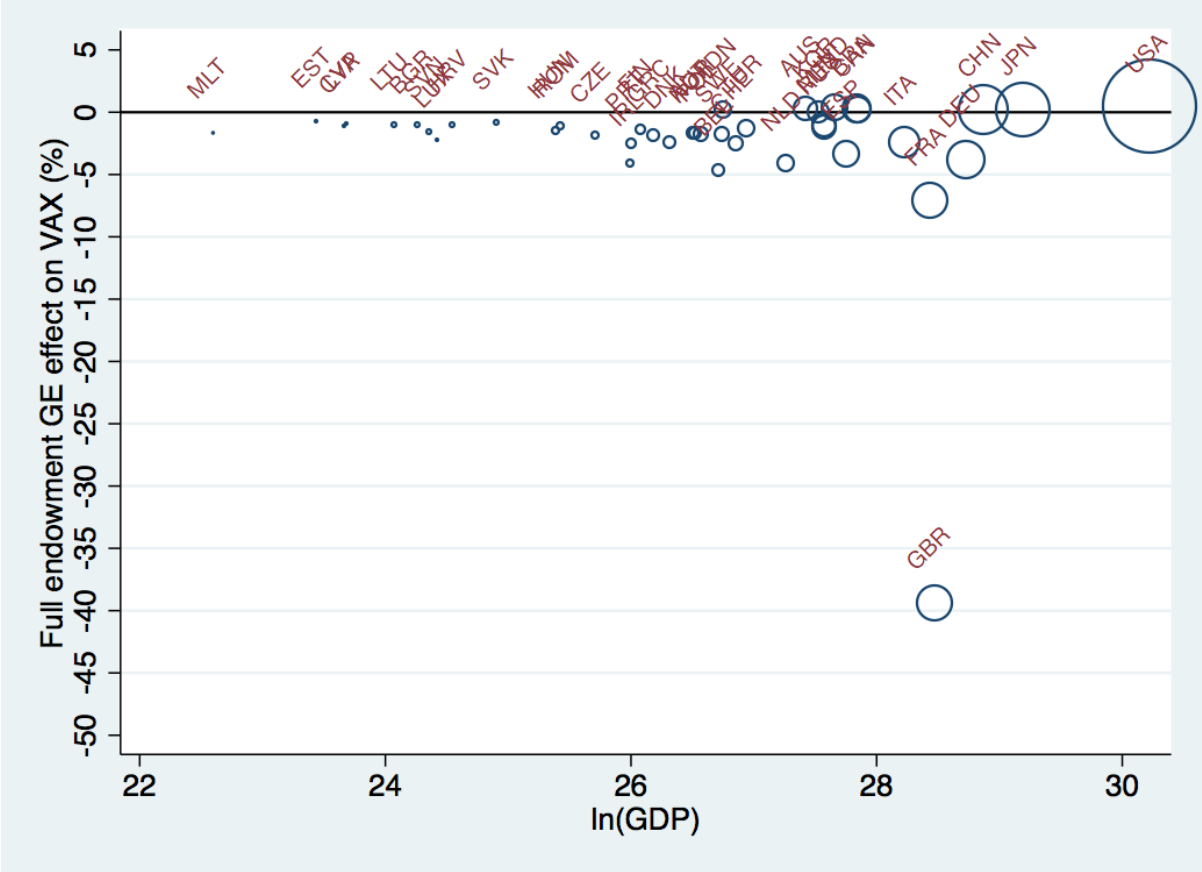

Fig. 1. "Hard Brexit" – UK terminates EU membership and membership in all other EU-based trade agreements. *Notes:* Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014. For a comparison with gross trade, see Figure A1 in the Appendix

As Figure 1 makes clear, a hard Brexit scenario has a strong negative impact on the value-added exports of the UK, decreasing by 39% because trade with the (remainder of the) EU becomes more expensive. It shows the asymmetric impact of a hard Brexit in which, not very surprisingly, the exports and thereby the UK economy are hit much harder than the other EU member states or non-EU countries. These countries also experience a trade decline, but to a lesser extent than for the UK, because the UK market is smaller than that of the EU. The impact is also stronger if one focuses on VAX, as we do here, when compared with the impact of on gross trade as can be seen by comparing Figure 1 with the results for gross trade

in Figure A1 in the Appendix. The main reason for this difference (which holds for all our scenarios) is that the value-added data take the intricate production value chain linkages between, in *casu* the UK and the rest of the world, into account whereas the gross trade data do not do so.

Figure 2 gives a detailed or 'zoomed in' view of the hard Brexit results as shown by Figure 1 so as to highlight that (mainly) other EU countries are also negatively affected by a hard Brexit in terms of their value-added exports. This holds first and foremost for France, where value exports decrease about 7%, and countries such as Ireland, Belgium, the Netherlands, and Germany who face a decrease in VAX of about 4%. Most other EU countries see their value-added exports drop by 1-2%, with the EU27 (excl. UK) average at -2%. Note that non-European countries are *not* really affected by a hard Brexit.

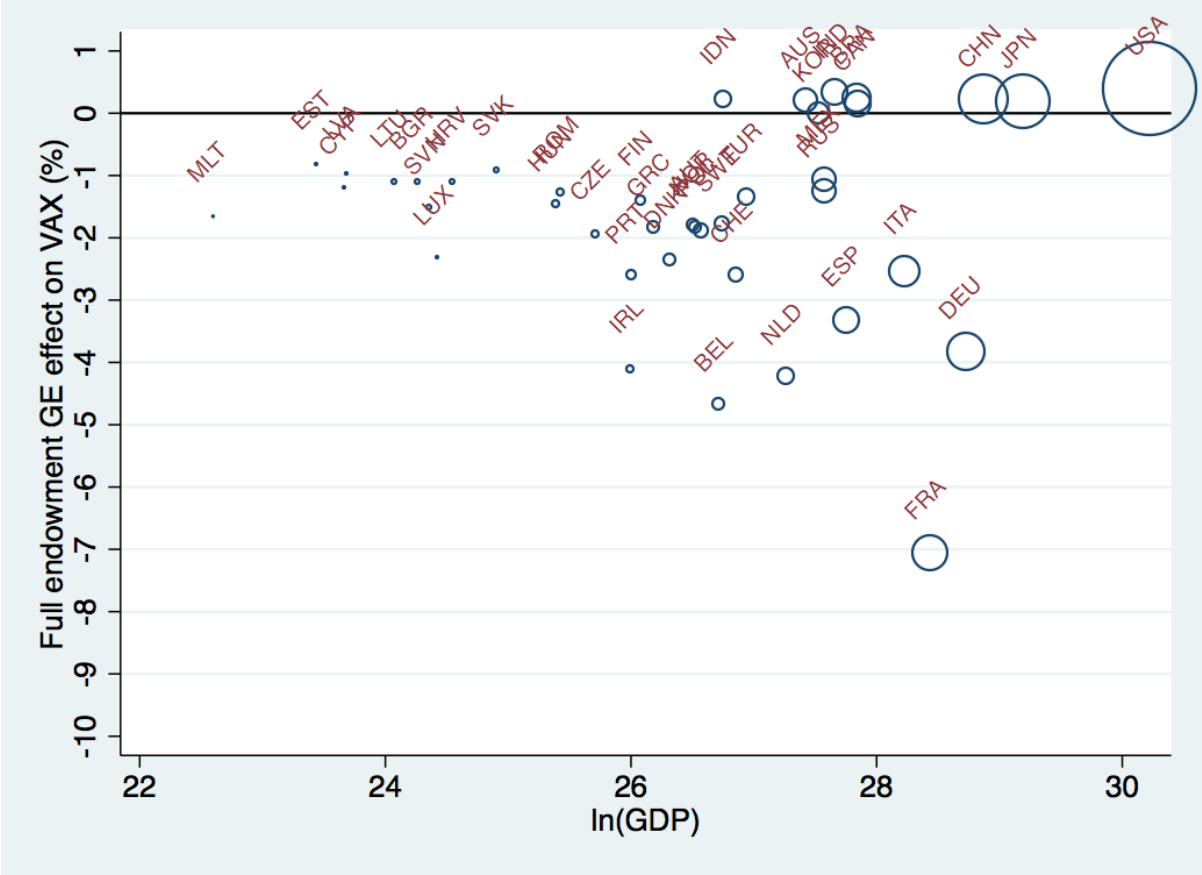

Fig. 2. "Hard Brexit" – Detailed view of **Figure 1** without the UK

As a milder version of the hard Brexit scenario we also looked into a "soft" Brexit option whereby the UK leaves the EU, but somehow manages to retain all other trade agreements with non-EU countries that it currently enjoys as an EU member state. Figure 3 shows the results. The main message is that the negative impact of Brexit is only slightly mitigated under this scenario: the UK's VAX fall by 32% compared to 39% under a hard Brexit scenario. The consequences of Brexit are obviously also reversed for the non-EU countries with which the EU has a trade agreements. The effect for other countries are basically unchanged.

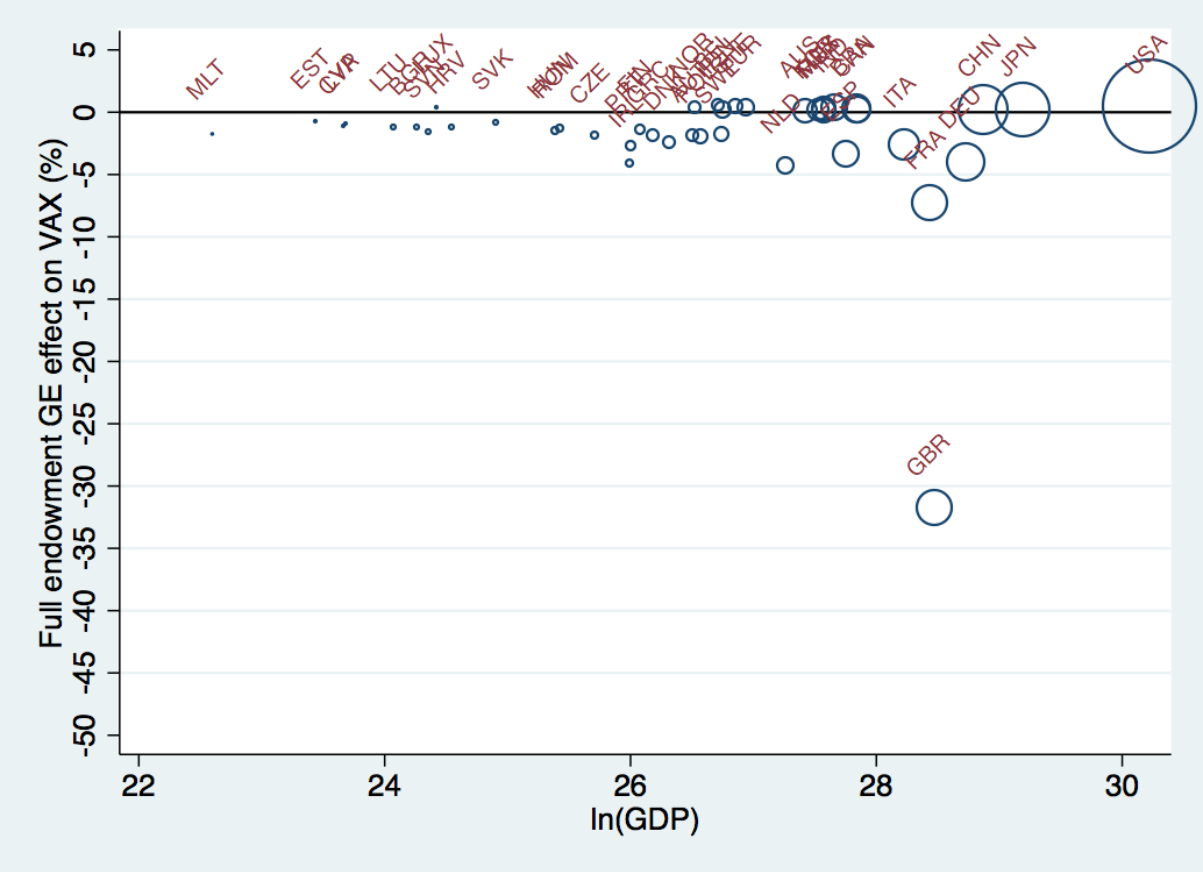

Fig. 3. "Soft Brexit" – UK terminates EU membership and retains membership in all other EU-based trade agreements. *Notes:* Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014

The conclusion that arises from Figures 1-3 is clear. Brexit will have a strong negative impact on the value-added exports of the UK. If no deal is struck between the UK government and the EU now that the Article 50 procedure has begun, our estimates suggests that the UK will experience a very substantial decline in VAX by almost 40%. The remaining EU countries are also negatively affected in terms of their VAX, with the largest impact occurring for the UK's main trading partners in the EU. Given these rather bleak long-term trade effects of Brexit, it is perhaps no wonder that the UK government has signalled to actively seek to establish other (new) trade agreements with trading partners outside the UK. Headed by Prime Minister Theresa May, the UK government has invoked the idea of "Global Britain" where the UK by inter alia establishing new trade agreements arguably would be able to off-set the effects of Brexit for the UK economy. It is to this scenario that we turn to next.

3.2 Brexit with Global Britain

In this sub-section, we assume that a hard Brexit has materialized and then look into the effects of alternative trade agreements by the UK on the value-added exports for the UK and the other countries in our sample. Inspired by Donald Trump's vocal support for Brexit and early talks by Trump with May after he became president of the USA, Figure 4 shows the effects of a bilateral trade agreement between the UK and the USA. Since we assume that this trade agreement is struck with the full Brexit in place, one should compare the outcomes in Figure 4 with those reported in Figure 1. The main effect of the trade agreement between the UK and the USA is that it increases the value-added export for both countries by about 4 and 2 percentage points, respectively, relative to the starting point of a hard Brexit. For the UK, this implies that the negative impact of Brexit is only marginally offset by such a bilateral trade agreement with the USA (compare the -39% in Figure 1 with the -35% in Figure 4; also see Table A1 for exact values). Easier access to the US market compensates the trade loss of

Brexit to some extent, but within the logic of the gravity market the US is further away and thereby less attractive.

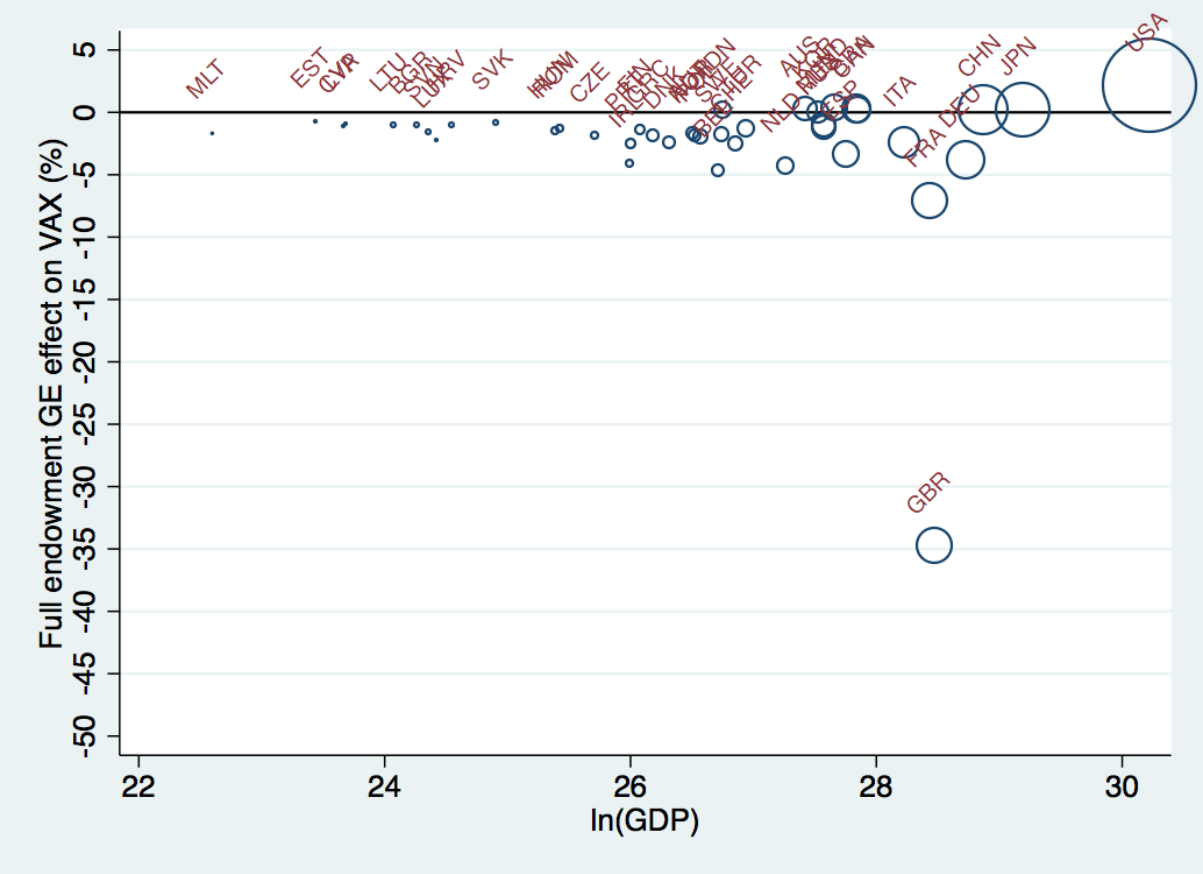

Fig. 4. UK-US-FTA – "Hard Brexit", followed by a trade agreement between the UK and US. *Notes:* Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014

A bilateral trade agreement between the UK and China would have similar effects (not shown here) in the sense that it would marginally raise the UK's value-added exports, but this again falls short to compensate for Brexit. This may lead one to conclude that the Global Britain scenario can simply not offset the negative trade effects, as measured by the change in value-added exports, of Brexit. But this ignores the fact that China and the UK are only two of the non-EU countries that the UK trades with. In order to investigate the maximum trade potential of the Global Britain scenario, we also analysed what happens if the UK goes for a

hard Brexit but at the same time manages to strike a trade agreement with all other countries in our sample outside the EU. As Figure 5 shows, this scenario would indeed provide a boost for the value-added exports of the UK and the other countries concerned (see besides the USA and China now also an increase in VAX for e.g. Japan, Russia or Canada). For the UK, it remains however the case that the combination of hard Brexit with a Global Britain scenario is still negative to the extent that its value-added exports fall by 16%.

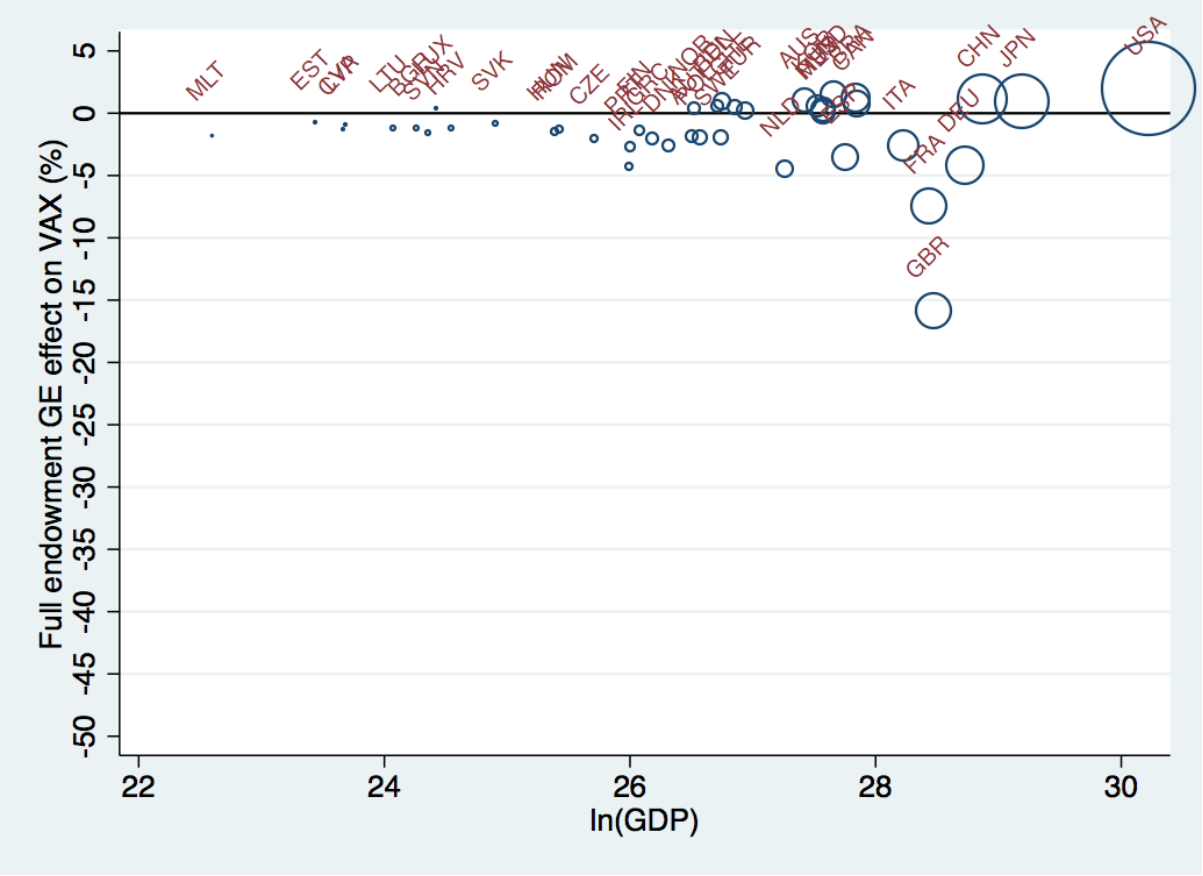

Fig. 5. UK-WORLD-TA – "Hard Brexit", followed by the UK joining trade agreements with all countries in the world *except* EU members. *Notes:* Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014

All in all, the conclusion from the estimation results in section 3.1 (Brexit only) and section 3.2 (Brexit *cum* Global Britain) must be that not only will Brexit have a strong negative trade impact on the UK, but also that it is rather difficult to see how these negative effects can be

more than offset by other trade agreements by the UK. The hard Brexit case as summarized by Figure 1 assumes that the UK will be not able to come to a new trade agreement with the EU before March 2019 (2 years after the Article 50 procedure began) and that all of the UK's trade with the EU (and the other countries with which the EU has a trade agreement) will take place under basic WTO rules (see De Grauwe, 2016). In the current discussion in the UK, the option "better no deal than a bad deal" with the EU is considered to be a possible outcome. When it comes to the UK's trade, the "no deal" world will look like Figure 1. At the other extreme of the "no deal" option is a variant of a Norway scenario whereby the UK would (continue to have) full access to the EU's single market, but without the free movement of people that applies to Norway. As a non-EU member, Norway effectively takes part in the EU's single market much like a regular EU member, but it does so with the free movement of people as is required by EU membership which, given the importance of labour migration in the Brexit debate, might limit the likelihood of this scenario for the UK. In terms of our analysis – where, as we stated before, factor mobility is not taken into account – the expected long and difficult negotiations that would result in a Norway-type of deal, leaving aside the issue of factor mobility, would to a large extent replicate the current trade agreement between the UK and the EU. Brexit would then lead to new situation where the UK's trade agreement with the EU would essentially copy, from a trade perspective, the current situation where the UK is an EU member (for a different and more pessimistic view, see Baier et al. 2008).

3.3 Trumping the Union Jack flat

In our final set of analyses, we aim to put the possible trade impact of Brexit into some perspective by investigating the trade effects using the same estimation procedure as before of alternative dissolutions of trade agreements. In each of the examples we consider, the question is: what are the "knock-on" effects of these dissolutions, over and above the effects of a hard Brexit? The first example takes an election promise by Donald Trump to its logical conclusion by looking into the impact on value-added exports that would come from the dissolution of NAFTA, the trade agreement between Canada, Mexico and the USA. From Figure 6 we can see that dissolving NAFTA would have a clearly negative impact on the VAX of the 3 countries that make up NAFTA but it would not, recall again Figure 1, have much of a discernible effect on the value-added exports of the other countries in our sample, including the UK.

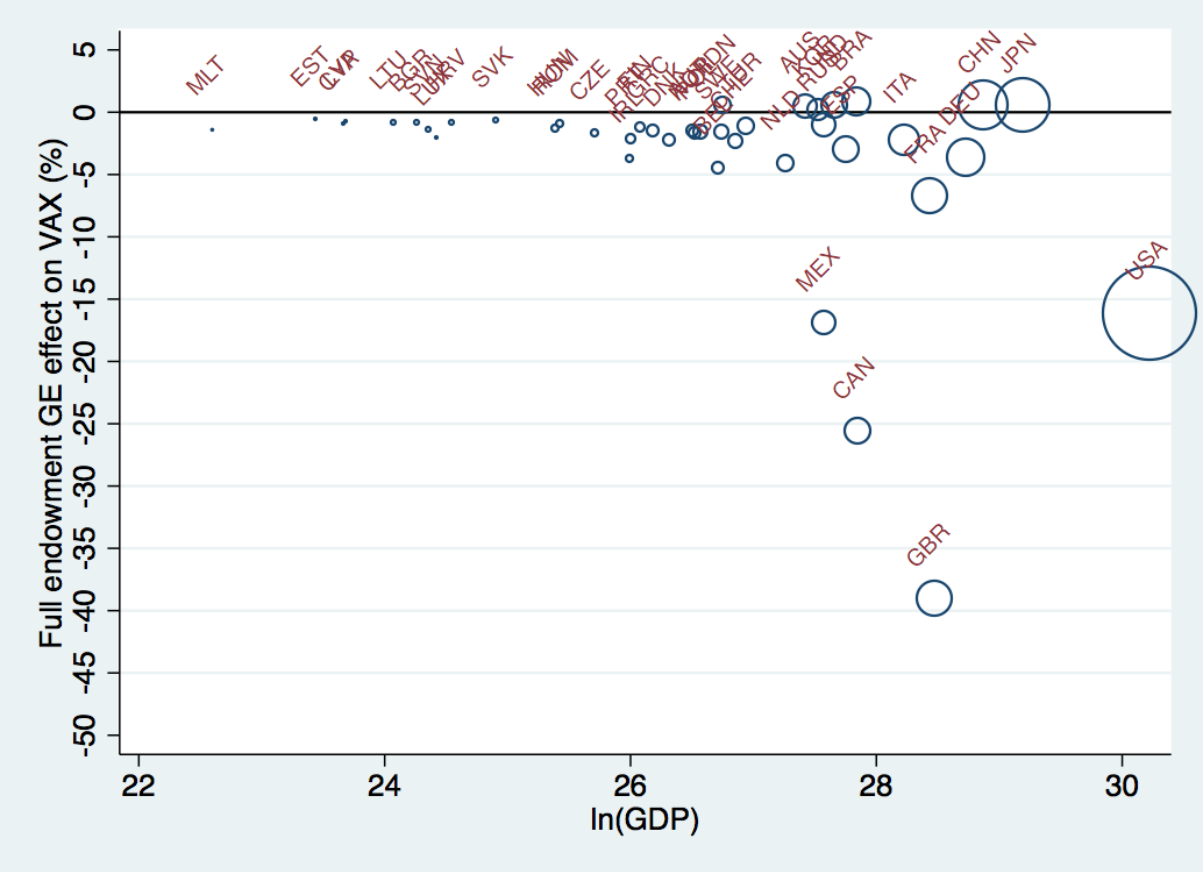

Fig. 6. No-NAFTA – "Hard Brexit", followed by the US dissolving NAFTA. *Notes:* Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014

More relevantly perhaps for the purpose of our present paper, where we are primarily concerned with the impact of Brexit for the UK and the EU, is a scenario where the Brexit is followed by other "exits" from the EU with the result that the EU itself and thereby the single market ceases to exist. In our estimations, this simply means that all EU countries will experience their own (hard) Brexit, so to say. As Figure 7 illustrates, this has strong negative effects on the VAX for all (former) EU members; the impact is the strongest for the main intra-EU trading countries like France, Germany, the Netherlands but also the UK. For these countries, the negative trade effects are in the range of what we found for an isolated Brexit in Figure 1 (note, all other non-EU TAs remain active).

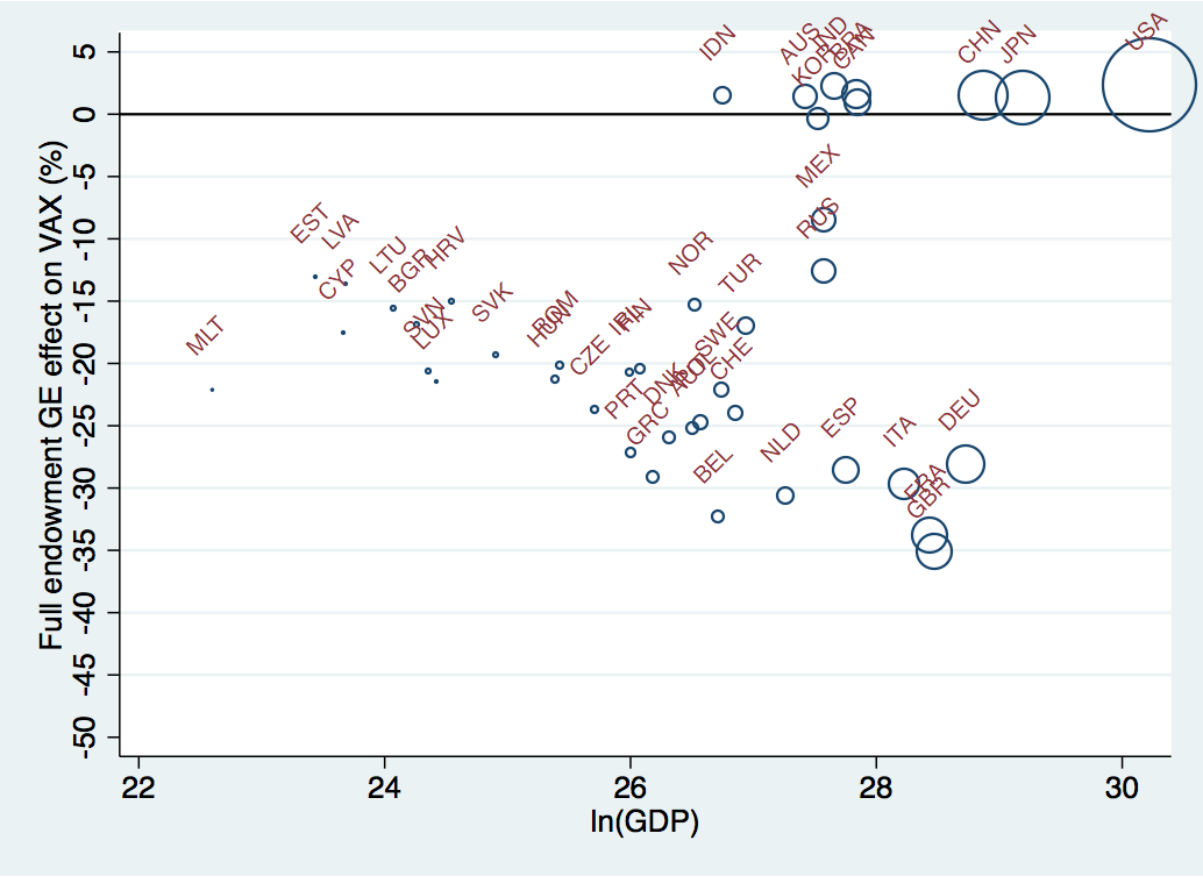

Fig 7. No-EU – "Hard Brexit", followed by a dissolution of the EU and termination of EU countries' membership in EU-related PTAs. *Notes:* Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014

Our final and truly bleak trade scenario is that we estimate the gravity equation (2) and construct our counterfactual as outlined in section 2 under the assumption that a "hard Brexit" is accompanied by all-out global trade war where all existing trade agreements would be dissolved. Figure 8 shows the results for this "no trade agreement left" scenario. The main difference with Figure 1 (hard Brexit only) or Figure 7 (hard Brexit and dissolution EU as trade agreement) is that now the rest of the world, that is to say the non-EU countries, is also severely affected. This is especially true for countries in our sample that are not only relatively small and open but also relatively heavily dependent on trade in modern global value chains like Mexico or Korea. Under this scenario, unlike with most of the other trade agreement scenarios we discussed, there are almost only losers with countries witnessing a fall in their value-added exports, see also Table A3 for the exact values.

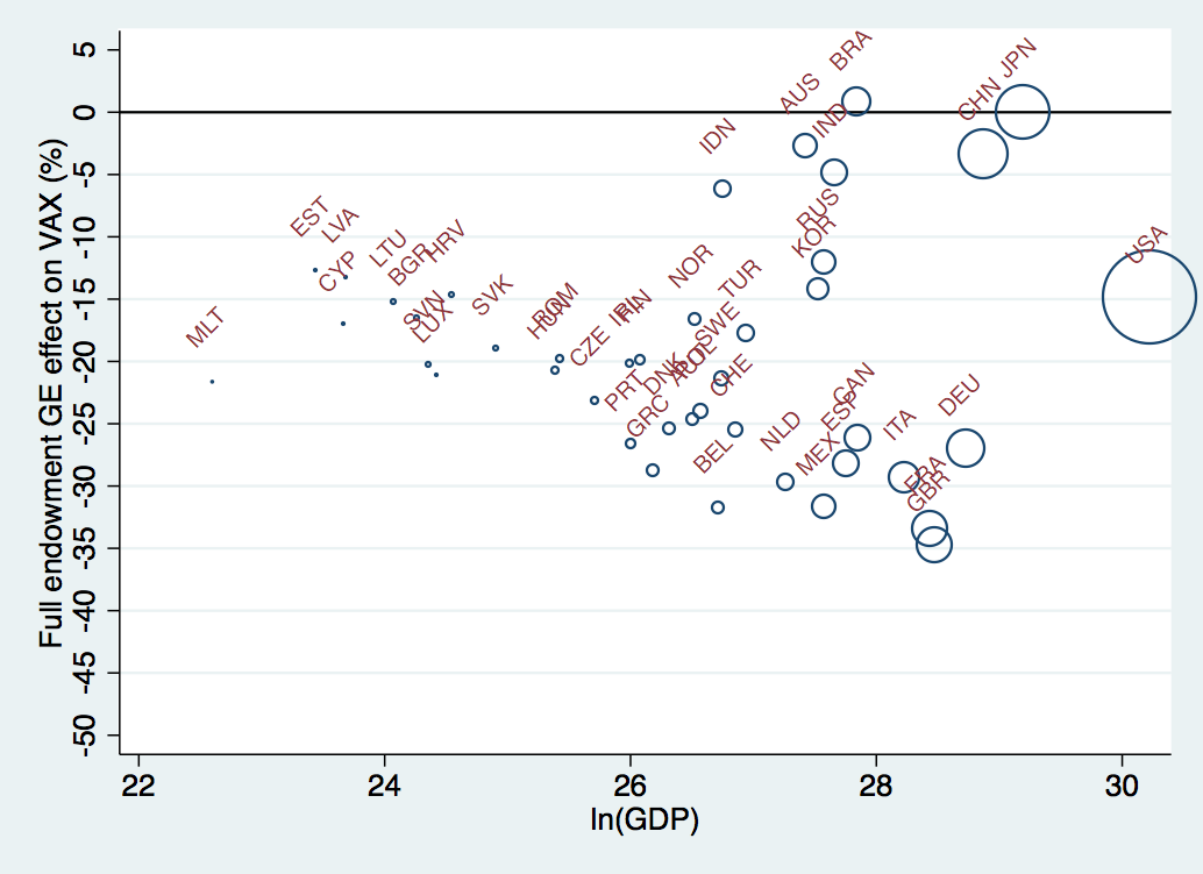

Fig. 8. No-TA – "Hard Brexit", followed by a dissolution of all trade agreements worldwide.

Notes: Bubbles proportional to countries' value-added exports. The data are averages for the period 2000-2014

4 Conclusions

The UK decided, following a referendum in 2016, to leave the EU. The negotiations between the UK and EU to determine under what conditions the Brexit should take place, started in March 2017. From an international trade perspective, the Brexit is puzzling, as almost all studies predict that trade with the EU will decrease significantly.

The UK government states that it is aiming to replace the current UK membership of the EU by other, broad, trade agreements. However, at this stage it is not clear what a new trade agreement would look like and which countries could be involved in these new agreements.

This paper reviews the alternatives that the UK government has. The central question we try to answer is: does the UK have an alternative compared to the current membership of the EU, that is, an alternative that would compensate for the large negative trade shock of Brexit. Reviewing the options that have emerged in discussions on Brexit, such as a broad agreement with the US, China, or all countries except the EU, our conclusion is simple: the UK has no trade-enhancing alternative other than an agreement that mimics, as much as possible, the current situation without formally being an EU member.

Our analysis has emphasized the trade consequences for the UK economy as a whole vis-à-vis the world economy by focussing on value-added exports. Future research could look into the consequences of Brexit by zooming in on certain sectors or regions in the UK and by also taking the political economy aspects into account (see Becker et al. 2016; Los et al. 2017).

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Appendix

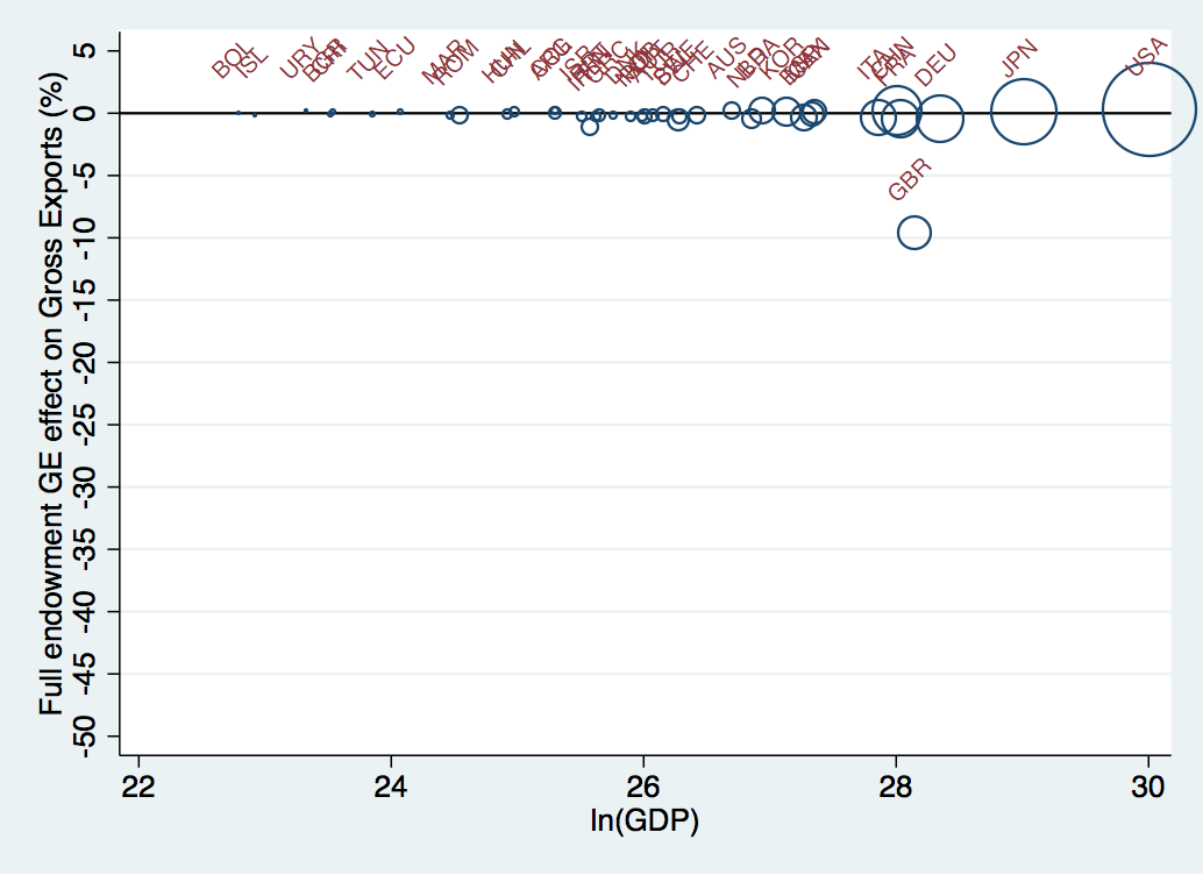

Fig. A1. "Hard Brexit" – UK terminates EU membership and membership in all other EU-based trade agreements. *Notes:* Dependent variable: Gross trade. Underlying gross trade and production data generously provided by Mario Larch as used in Anderson et al. (2015) and Anderson and Yotov (2016). Bubbles proportional to countries' gross exports.

Table A1. Full endowment general equilibrium effects for counterfactual scenarios (in %, based on 2000-2014 averages)

Country	Name	Gross trade	Value-added exports						
		Hard Brexit	Hard Brexit	Soft Brexit	UK-US-TA	UK-WORLD-TA	No-NAFTA	No-EU	No-TA
AUS	Australia	0,10	0,19	0,14	0,18	0,93	0,48	1,33	-2,83
AUT	Austria	-0,20	-1,81	-1,91	-1,84	-1,96	-1,64	-25,33	-24,67
BEL	Belgium	-0,53	-4,70	0,53	-4,76	0,50	-4,55	-32,45	-31,80
BGR	Bulgaria	-0,09	-1,11	-1,19	-1,13	-1,20	-0,94	-16,88	-16,53
BRA	Brazil	0,12	0,24	0,19	0,21	1,22	0,71	1,57	0,69
CAN	Canada	0,04	0,15	0,11	0,09	0,74	-25,72	0,89	-26,20
CHE	Switzerland	-0,27	-2,62	0,34	-2,66	0,34	-2,48	-24,02	-25,52
CHN	China	0,08	0,20	0,15	0,18	0,97	0,43	1,42	-3,35
CYP	Cyprus	n/a	-1,21	-1,29	-1,23	-1,33	-0,98	-17,63	-17,14
CZE	Czech Republic	n/a	-1,95	-2,05	-1,97	-2,09	-1,77	-23,73	-23,18
DEU	Germany	-0,48	-3,83	-3,99	-3,88	-4,16	-3,66	-28,07	-27,06
DNK	Denmark	-0,35	-2,37	-2,49	-2,41	-2,57	-2,17	-26,03	-25,35
ESP	Spain	-0,46	-3,32	-3,45	-3,37	-3,57	-2,96	-28,64	-28,33
EST	Estonia	n/a	-0,82	-0,88	-0,84	-0,87	-0,69	-13,09	-12,78
FIN	Finland	-0,26	-1,43	-1,53	-1,46	-1,57	-1,22	-20,49	-19,93
FRA	France	-0,55	-7,06	-7,30	-7,15	-7,57	-6,83	-33,91	-33,39
GBR	United Kingdom	-9,69	-39,35	-31,87	-34,84	-15,91	-39,11	-35,16	-34,74
GRC	Greece	-0,25	-1,86	-1,97	-1,89	-2,03	-1,58	-29,17	-28,72
HRV	Croatia	n/a	-1,11	-1,19	-1,13	-1,20	-0,97	-15,10	-14,72
HUN	Hungary	-0,21	-1,46	-1,55	-1,48	-1,57	-1,29	-21,30	-20,81
IDN	Indonesia	n/a	0,19	0,14	0,18	0,93	0,42	1,37	-6,31
IND	India	n/a	0,30	0,22	0,28	1,38	0,56	2,11	-4,97
IRL	Ireland	-1,22	-4,13	-4,26	-4,19	-4,41	-3,90	-20,78	-20,21
ITA	Italy	-0,36	-2,56	-2,67	-2,59	-2,76	-2,29	-29,78	-29,40
JPN	Japan	0,08	0,17	0,13	0,16	0,89	0,41	1,28	0,02
KOR	South Korea	0,06	-0,02	0,09	-0,03	0,58	0,17	-0,39	-14,33
LTU	Lithuania	n/a	-1,11	-1,19	-1,13	-1,20	-0,95	-15,64	-15,27
LUX	Luxembourg	n/a	-2,34	0,32	-2,37	0,33	-2,22	-21,62	-21,21
LVA	Latvia	n/a	-1,01	-1,08	-1,02	-1,08	-0,86	-13,70	-13,37

MEX	Mexico	-0,09	-1,07	0,11	-1,11	0,05	-16,95	-8,51	-31,78
MLT	Malta	n/a	-1,65	-1,74	-1,68	-1,80	-1,41	-22,12	-21,63
NLD	Netherlands	-0,63	-4,25	-4,42	-4,31	-4,58	-4,10	-30,69	-29,87
NOR	Norway	-0,39	-1,85	0,24	-1,88	0,24	-1,68	-15,45	-16,70
POL	Poland	-0,26	-1,89	-1,99	-1,92	-2,05	-1,67	-24,71	-24,09
PRT	Portugal	-0,32	-2,63	-2,73	-2,67	-2,83	-2,25	-27,20	-26,70
ROM	Romania	-0,28	-1,30	-1,39	-1,32	-1,42	-1,10	-20,36	-19,89
RUS	Russia	n/a	-1,24	0,19	-1,27	0,18	-1,02	-12,66	-12,15
SVK	Slovakia	n/a	-0,92	-0,99	-0,93	-0,99	-0,78	-19,48	-19,04
SVN	Slovenia	n/a	-1,54	-1,62	-1,56	-1,64	-1,37	-20,70	-20,29
SWE	Sweden	-0,30	-1,78	-1,88	-1,81	-1,94	-1,56	-22,08	-21,43
TUR	Turkey	-0,24	-1,36	0,22	-1,39	0,21	-1,14	-17,14	-17,77
TWN	Taiwan	n/a	0,12	0,09	0,11	0,64	0,28	0,93	1,17
USA	United States	0,21	0,37	0,29	2,08	1,93	-16,20	2,31	-14,95
EU27	EU27 (excl. GBR) average	-0,40	-2,27	-2,07	-2,30	-2,13	-2,06	-22,99	-22,47

Table A2. Full endowment general equilibrium effects for "Hard Brexit" on value-added exports (in %, annual effects)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Average
AUS	0,16	0,14	0,17	0,17	0,24	0,23	0,23	0,23	0,20	0,18	0,17	0,18	0,17	0,18	0,18	0,19
AUT	-1,70	-1,52	-1,58	-1,60	-2,04	-2,08	-2,08	-2,03	-1,89	-1,87	-1,83	-1,75	-1,75	-1,75	-1,75	-1,81
BEL	-3,94	-3,54	-3,81	-3,86	-4,75	-5,12	-5,32	-5,31	-5,41	-5,05	-5,03	-4,87	-4,93	-4,79	-4,83	-4,70
BGR	-0,98	-0,94	-1,02	-1,04	-1,21	-1,23	-1,22	-1,36	-1,29	-1,25	-1,10	-0,99	-0,99	-1,01	-1,02	-1,11
BRA	0,23	0,20	0,21	0,21	0,25	0,26	0,27	0,28	0,28	0,24	0,25	0,25	0,24	0,25	0,25	0,24
CAN	0,11	0,10	0,12	0,12	0,15	0,16	0,17	0,18	0,17	0,16	0,16	0,16	0,16	0,16	0,15	0,15
CHE	-2,52	-2,32	-2,44	-2,44	-2,90	-3,00	-2,99	-2,84	-2,67	-2,58	-2,58	-2,49	-2,48	-2,53	-2,56	-2,62
CHN	0,18	0,16	0,18	0,18	0,23	0,22	0,21	0,21	0,20	0,19	0,19	0,20	0,19	0,20	0,19	0,20
CYP	-1,11	-1,01	-1,09	-1,06	-1,44	-1,44	-1,42	-1,43	-1,40	-1,32	-1,22	-1,09	-1,03	-1,02	-1,02	-1,21
CZE	-1,65	-1,52	-1,67	-1,68	-2,17	-2,24	-2,27	-2,29	-2,18	-2,10	-2,06	-1,90	-1,85	-1,83	-1,81	-1,95
DEU	-3,86	-3,31	-3,32	-3,41	-3,96	-4,19	-4,31	-4,12	-4,06	-3,92	-3,99	-3,87	-3,76	-3,71	-3,65	-3,83
DNK	-2,17	-1,92	-2,11	-2,10	-2,60	-2,68	-2,77	-2,82	-2,63	-2,49	-2,37	-2,25	-2,22	-2,22	-2,25	-2,37
ESP	-3,10	-2,76	-3,01	-3,09	-3,84	-4,03	-4,12	-4,11	-3,80	-3,33	-3,20	-2,97	-2,84	-2,79	-2,86	-3,32
EST	-0,71	-0,65	-0,72	-0,74	-0,98	-0,99	-1,02	-1,03	-0,90	-0,86	-0,78	-0,72	-0,72	-0,75	-0,77	-0,82
FIN	-1,31	-1,17	-1,26	-1,30	-1,61	-1,67	-1,64	-1,61	-1,51	-1,52	-1,46	-1,38	-1,35	-1,35	-1,37	-1,43
FRA	-5,63	-5,10	-5,63	-5,81	-7,18	-7,75	-8,08	-8,18	-8,04	-7,71	-7,67	-7,38	-7,35	-7,22	-7,19	-7,06
GBR	-32,36	-29,49	-32,88	-33,37	-41,08	-42,53	-42,98	-43,78	-45,03	-43,83	-43,37	-40,99	-39,44	-40,32	-38,79	-39,35
GRC	-1,96	-1,77	-1,91	-1,91	-2,17	-2,15	-2,18	-2,18	-1,98	-1,90	-1,75	-1,57	-1,48	-1,47	-1,48	-1,86
HRV	0,24	0,23	-1,18	-1,21	-1,53	-1,55	-1,53	-1,54	-1,44	-1,41	-1,27	-1,15	-1,10	-1,13	-1,12	-1,11
HUN	-1,31	-1,20	-1,31	-1,32	-1,81	-1,82	-1,77	-1,72	-1,60	-1,51	-1,43	-1,30	-1,26	-1,28	-1,30	-1,46
IDN	0,14	0,13	0,16	0,16	0,21	0,21	0,22	0,22	0,23	0,19	0,21	0,20	0,21	0,21	0,21	0,19
IND	0,25	0,23	0,25	0,25	0,33	0,34	0,35	0,36	0,34	0,30	0,31	0,31	0,30	0,29	0,29	0,30
IRL	-4,14	-3,42	-3,56	-3,69	-4,73	-5,14	-5,27	-5,31	-4,84	-4,17	-3,85	-3,51	-3,33	-3,46	-3,53	-4,13
ITA	-2,43	-2,14	-2,35	-2,37	-2,84	-2,97	-3,05	-2,96	-2,79	-2,63	-2,64	-2,46	-2,28	-2,22	-2,20	-2,56
JPN	0,15	0,14	0,15	0,14	0,18	0,19	0,19	0,18	0,19	0,16	0,15	0,18	0,18	0,19	0,19	0,17
KOR	0,12	0,11	0,14	0,13	0,16	0,17	0,18	0,18	0,17	0,12	0,13	-0,49	-0,46	-0,44	-0,44	-0,02
LTU	-0,90	-0,83	-0,91	-0,94	-1,33	-1,35	-1,36	-1,40	-1,31	-1,20	-1,11	-1,03	-0,98	-1,00	-1,02	-1,11
LUX	-2,02	-1,88	-2,07	-2,13	-2,58	-2,70	-2,59	-2,55	-2,55	-2,46	-2,40	-2,31	-2,36	-2,26	-2,32	-2,34
LVA	-0,78	-0,73	-0,79	-0,80	-1,20	-1,23	-1,30	-1,36	-1,22	-1,10	-0,96	-0,91	-0,90	-0,91	-0,92	-1,01

MEX	-1,05	-0,96	-1,02	-1,02	-1,27	-1,26	-1,23	-1,23	-1,14	-1,05	-1,00	-0,94	-0,91	-0,93	-0,95	-1,07
MLT	-1,62	-1,41	-1,46	-1,47	-2,00	-2,02	-1,97	-1,87	-1,73	-1,77	-1,67	-1,49	-1,45	-1,44	-1,43	-1,65
NLD	-3,84	-3,51	-3,72	-3,76	-4,58	-4,82	-4,97	-5,00	-4,76	-4,45	-4,37	-4,15	-4,08	-3,91	-3,90	-4,25
NOR	-1,66	-1,50	-1,72	-1,73	-2,03	-2,00	-1,99	-2,09	-1,85	-1,98	-1,94	-1,78	-1,76	-1,82	-1,88	-1,85
POL	-1,75	-1,55	-1,64	-1,60	-2,13	-2,17	-2,20	-2,25	-2,17	-1,96	-1,92	-1,80	-1,73	-1,70	-1,74	-1,89
PRT	-2,68	-2,40	-2,58	-2,53	-3,03	-3,10	-3,03	-2,98	-2,85	-2,72	-2,62	-2,35	-2,20	-2,19	-2,22	-2,63
ROM	-1,11	-1,04	-1,10	-1,14	-1,35	-1,41	-1,43	-1,71	-1,58	-1,43	-1,35	-1,24	-1,19	-1,19	-1,21	-1,30
RUS	-0,97	-0,99	-1,08	-1,08	-1,34	-1,35	-1,39	-1,49	-1,38	-1,32	-1,28	-1,22	-1,24	-1,27	-1,25	-1,24
SVK	0,27	0,26	0,30	0,30	-1,42	-1,48	-1,48	-1,47	-1,41	-1,41	-1,36	-1,25	-1,19	-1,20	-1,21	-0,92
SVN	-1,42	-1,27	-1,35	-1,35	-1,78	-1,81	-1,79	-1,80	-1,69	-1,65	-1,57	-1,43	-1,38	-1,37	-1,37	-1,54
SWE	-1,70	-1,50	-1,61	-1,62	-1,98	-2,03	-2,01	-2,01	-1,87	-1,82	-1,79	-1,70	-1,66	-1,69	-1,73	-1,78
TUR	-1,44	-1,07	-1,18	-1,26	-1,54	-1,60	-1,59	-1,59	-1,43	-1,30	-1,38	-1,32	-1,23	-1,28	-1,26	-1,36
TWN	0,13	0,11	0,11	0,11	0,16	0,15	0,15	0,14	0,14	0,11	0,11	0,11	0,11	0,11	0,10	0,12
USA	0,34	0,30	0,35	0,35	0,45	0,46	0,46	0,45	0,42	0,34	0,35	0,34	0,33	0,33	0,34	0,37
EU27 (excl. GBR) average	-1,97	-1,76	-1,94	-1,97	-2,53	-2,64	-2,67	-2,68	-2,55	-2,41	-2,33	-2,18	-2,12	-2,11	-2,12	-2,27

Table A3. Full endowment general equilibrium effects for counterfactual scenarios (in millions of US$ - based on 2000-2014 averages)

Country	Hard Brexit	Soft Brexit	UK-US-TA	UK-WORLD-TA	No-NAFTA	No-EU	No-TA
AUS	1.395	1.038	1.295	6.833	3.561	9.841	-20.905
AUT	-3.791	-3.993	-3.845	-4.090	-3.418	-52.927	-51.553
BEL	-10.818	1.219	-10.947	1.144	-10.456	-74.626	-73.132
BGR	-270	-288	-275	-292	-229	-4.107	-4.023
BRA	2.724	2.102	2.370	13.631	7.933	17.571	7.729
CAN	1.367	1.059	794	6.845	-238.760	8.262	-243.178
CHE	-7.941	1.026	-8.051	1.035	-7.497	-72.704	-77.254
CHN	6.879	5.094	6.370	34.199	14.959	49.945	-117.575
CYP	-163	-175	-167	-181	-132	-2.389	-2.323
CZE	-1.802	-1.893	-1.827	-1.938	-1.639	-21.957	-21.451
DEU	-74.666	-77.814	-75.735	-81.162	-71.318	-547.258	-527.550
DNK	-3.850	-4.036	-3.912	-4.167	-3.523	-42.231	-41.124
ESP	-29.942	-31.054	-30.376	-32.144	-26.665	-258.059	-255.203
EST	-79	-84	-80	-83	-66	-1.251	-1.222
FIN	-1.958	-2.083	-1.995	-2.138	-1.664	-27.971	-27.209
FRA	-119.468	-123.541	-120.970	-127.995	-115.482	-573.702	-565.001
GBR	-659.069	-533.769	-583.457	-266.441	-655.121	-588.816	-581.798
GRC	-3.520	-3.724	-3.572	-3.850	-2.988	-55.233	-54.387
HRV	-329	-352	-334	-354	-286	-4.473	-4.361
HUN	-877	-927	-890	-943	-774	-12.772	-12.478
IDN	763	569	706	3.665	1.640	5.379	-24.807
IND	2.966	2.192	2.786	13.544	5.526	20.743	-48.899
IRL	-3.724	-3.842	-3.780	-3.979	-3.519	-18.732	-18.220
ITA	-35.160	-36.764	-35.663	-37.980	-31.531	-409.721	-404.502
JPN	7.044	5.218	6.489	36.933	16.878	53.252	836
KOR	-94	578	-159	3.573	1.033	-2.436	-88.465
LTU	-203	-217	-206	-219	-174	-2.859	-2.791
LUX	-344	46	-347	48	-326	-3.168	-3.108
LVA	-138	-148	-140	-148	-118	-1.879	-1.833
MEX	-8.064	832	-8.372	379	-128.294	-64.380	-240.515
MLT	-61	-65	-62	-67	-52	-821	-803
NLD	-17.369	-18.033	-17.593	-18.708	-16.740	-125.320	-121.942
NOR	-3.801	501	-3.867	497	-3.450	-31.757	-34.320
POL	-4.526	-4.784	-4.599	-4.926	-4.008	-59.267	-57.799
PRT	-3.811	-3.956	-3.873	-4.099	-3.255	-39.407	-38.685
ROM	-1.129	-1.210	-1.149	-1.238	-959	-17.701	-17.296
RUS	-8.974	1.382	-9.158	1.319	-7.341	-91.345	-87.700
SVK	-349	-375	-354	-377	-296	-7.422	-7.252
SVN	-347	-366	-352	-371	-311	-4.685	-4.592
SWE	-4.575	-4.844	-4.657	-4.991	-4.012	-56.741	-55.077
TUR	-5.346	852	-5.448	816	-4.482	-67.163	-69.652
TWN	308	227	288	1.609	692	2.334	2.935
USA	47.592	36.693	264.513	245.030	-2.059.530	293.190	-1.901.519
EU27 (excl. GBR) total	-323.271	-323.302	-327.699	-335.247	-303.942	-2.426.680	-2.374.917